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SHORT COMMUNICATION

A PRELIMINARY REPORT ON THE MICRODISTRIBUTION OF BLACK FLY (DIPTERA: SIMULIIDAE) LARVAE FROM THE SERRA DOS ÓRGÃOS REGION, BRAZIL, AND ITS HABITAT QUALITY TRAITS

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ABSTRACT:

Black flies (Diptera: Simuliidae) are a worldwide distributed insect Family, comprised of more than 2,400 known species, most of which have hematophagous habits when adults, some of them being vectors of the Onchocerciasis and the Mansonelosis. Black fly larvae are filter feeding, and literature indicates that their distribution on a local scale is determined by microhabitat features, such as water current velocity, and habitat integrity degree. In this paper, preliminary data about the microdistribution of black flies is presented, and correlated to environmental traits such as water current velocity and habitat integrity. Our data suggests that *Simulium subnigrum* may be a bioindicator of more integer habitats, while the other studied species may be bioindicators of habitat degradation.

Keywords: microdistribution, black flies, habitat quality.

RESUMO:

Simulídeos (Diptera: Simuliidae) são uma família de insetos com distribuição global, composta de mais de 2400 espécies conhecidas, muitas das quais tem hábitos hematofágicos quando adultos, sendo algumas vetores da Oncocercose e da Mansonelose. Larvas de simulídeos são filtradoras, e a literatura indica que sua distribuição em uma escala local pode ser determinada por características do micro-habitat, como a velocidade da correnteza e o grau de integridade do habitat. Neste artigo, dados preliminares sobre a microdistribuição de simulídeos é apresentada e relacionada com características ambientais como a velocidade de correnteza e a integridade do habitat. Nossos dados sugerem que *Simulium subnigrum* pode ser um bioindicador de habitats mais íntegros, enquanto as demais espécies estudadas podem ser bioindicadores de degradação de habitat.

Palavras-chave: microdistribuição, simulídeos, qualidade de habitat.

Black flies (Diptera: Simuliidae) are an extremely diverse macroinvertebrate group, of great importance in lotic systems (Carvalho and Uieda, 2004). This insect family has a worldwide distribution, and is comprised of more than 2,400 known species, most of which have hematophagous habits when adults, some of them being vectors of the onchocerciasis and the mansonelosis.

Black fly larvae can be found in water courses of varying sizes, discharges, temperatures, pH and altitudes(Crosskey, 1990; Coscarón, 1991). Their larvae are filter-feeding, and as such, demand running water in order to feed on dissolved organic matter particles (Crosskey, 1990),where they usually are associated to rocks, riffle litter and riparian vegetation (Coscaron, 1991).

Figueiró and Gil-Azevedo (2010) report that although the amazon biome has an extensive literature on habitat preference (Hamada 1993; Hamada et al., 2002), little is known about microhabitat preference patterns in other biomes (Pepinelli et al., 2005; Figueiró et al., 2006, 2008, 2012, 2014; Bertazo and Figueiró 2012).

One of the environmental factors that can cause population explosions in black flies is the increased organic matter input in water courses, due to domestic waste, which in moderate levels enable the increased population growth, however, in extreme levels other factors, such as reduction in dissolved oxygen availability, can cause the depletion of these populations (Castex et al., 1988).

The effect of pollution on the distribution of black fly larvae, as well as microhabitat distribution, is poorly studied in the Neotropical region, with just a few articles addressing this issue (Junior et al., 2003;Strieder et al., 2006), while in the Paleartic region, Illesova et al. (2010) and Kazanci and Ertunç (2010) have explored the bioindicator potential of these organisms.

The aim of the present study was to investigate abiotic factors in the microhabitat level and their role shaping black fly taxocenoses, and to relate the habitat integrity degree with the community structure of black flies.Hence, we test the hypothesis that black fly taxocenosis should be different in stream sections with different habitat qualities, and investigate the association of species to different degrees of environmental integrity and abiotic factors.

The study was conducted in the Serra dos Órgãos National Park and its surroundings. The Park is located in the municipalities of Teresópolis, Petrópolis, Magé and Guapimirim, between the coordinates 22°34'30.15"S and 43°13'22.16"W. All studies were conducted in the municipality of Teresópolis, Rio de Janeiro/RJ.

The sampling was conducted in four different sites, three of them inside the protection area of the park (22º 27' 34" S, 42º 59' 82" W; 22º 26' 92" S, 43º 00' 24"W; 22º 26' 87" S , 43º 00' 45" W), and one of them in its surroundings (22º 26' 86" S, 42º 59' 06" W), in the dry seasons of 2012 and 2013. The three sampling sites inside the Park were characterized by dense canopy cover, while the site outside the park had larger width and less canopy cover. All sampling sites were predominantly composed of rocky stream beds. In each site, fifteen random quadrats of 30 X 30 cm were sampled, between the margin and the middle of the stream, in sections of about 15 meters, in order to represent the heterogeneity within each site.

Each site was also investigated in relation to its environmental quality, through the application of the modified (Buss, 2000) Riparian, Channel and Environmental (RCE) index protocol (Petersen, 1992), which is based in the evaluation of physical and environmental aspects associated to stream integrity. The score obtained from the application of the protocol determines the integrity degree of the stream: excellent, very good, good, regular and poor.

Each stream was also measured in relation to the width, and each quadrat had its depth and water current velocity measured, using the head rod method (Wilm and Storey, 1944) (Table 1). The larvae were collected and stored in separate plastic bags, containing 70% ethanol, and transported to quantification and identification in the Laboratório de Invertebrados (UERJ) and Laboratório de Biotecnologia Ambiental (UEZO).

Table 1: Black fly larvae abundances, mean values of the measured abiotic factors and RCE scores per site.

Site coordinates	*S 22°26'86" W 42°59'06"*	*S 22°27'34" W 42°59'82"*	*S 22°26'92" W 43°00'24"*	*S 22° 26' 87" W 43°00'45"*
S. (Chirostilbia) spp.	67	0	0	0
S. incrustatum	97	9	0	0
S. subnignum	5	20	1	1
RCE score	191	280	325	355
Width (meters)	2	1.2	0.8	1
Mean Velocity (m/ s-1)	0.750552	0.741804	0.669127	0.503909
Mean Depth (meters)	1.4	1.333333	1.266667	1.133333

Larvae were separated in different morphotypes, and last instar specimens were dissected and mounted in slides, according to

Calvão-Brito and Herzog (2003). These slides were then examined and identified from the respiratory filaments and cephalic spot patters, through direct comparison with the material from the laboratório de referencia Nacional em Simulídeos e Oncocercose (FIOCRUZ).

A total of 617 larvae were collected from two different species and three subgenera: *Simulium incrustatum* Lutz 1910, *Simulium subnigrum* Lutz 1910, *Simulium (Chirostilbia)* spp. (Table 1). The latter was impossible to differentiate, so we treated as one single taxonomic entity.

This set of species is composed by one widely distributed zoophilic species, *S.subnigrum*, one widely distributed anthropophilic species, *S.incrustatum* (Lutz, 1910; Araújo-Coutinho et al., 1999; Shelley et al., 2001) and a subgenera which comprises some important anthropophilic species.

Black fly species were sorted in water velocity classes, and submitted to a correspondence analysis, in order to reveal microhabitat associations, and depth, integrity and stream width were analyzed through a canonical correspondence analysis (CCA). For the CCA, data was log transformed, in order to avoid distortions and individual environmental variables used in the model were tested under 5,000 Monte Carlo permutations, thus only those variables with $p < 0.05$ were used in the model.

The correspondence analysis (Axis 1: 94,53% of inertia, Axis 2: 5,465% of inertia) showed Simulium (Chirostilbia) spp. and S.incrustatum associated to speeds between 0.47 – 0.88 m/s-1, while *S.subnigrum* was associated to faster currents, between 0.9 – 1.17 m/s-1(Fig. 1). The pattern of *S.incrustatum* showed a pattern consistent to what Figueiró et al. (2008) found, while on the other hand, *S.subnigrum* was not recorded by Figueiró et al. (2008), what may suggest that this species may be a superior competitor for micohabitats within faster currents, and thus its its presence affects the realized niche of *Simulium (Chirostilbia)* spp., therefore changing the distribution of these species through the water current gradient.

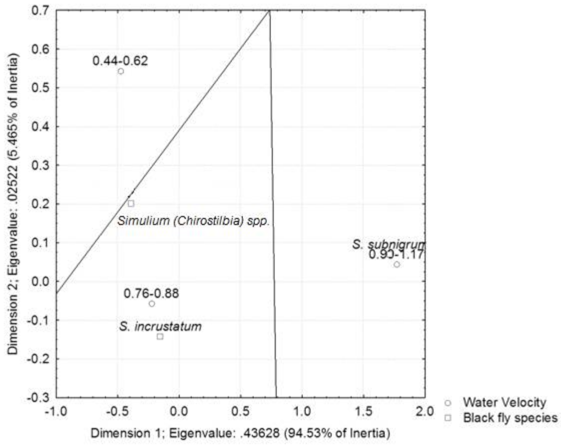

Figure 1: Correspondence analysis indicating that S.subnigrum was associated to faster water current speeds, while *S (Chirostilbia)* spp. and *S.incrustatum* were associated to intermediate velocities (Axis 1: 94,53% of inertia, Axis 2: 5,465% of inertia).

The CCA (Axis 1: eigenvalues=0.508, Axis 2: eigenvalues=0.176) showed that *S.subnigrum* was strongly associated to higher RCE scores (Fig. 2), indicating that this may be an indicator species of habitat integrity, while *S.incrustatum* and *Simulium (Chirostilbia)* spp. were associated to wider streams and lower RCE scores.

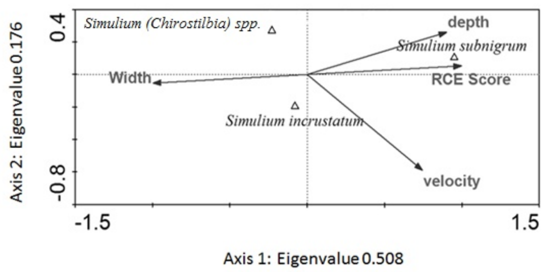

Figure 2: Canonical correspondence analysis showing that *S.subnigrum* was associated to more integer habitats, while *Simulium (Chirostilbia)* spp. and *S.incrustatum* were more associated to larger streams withmore deteriorated habitats (Axis1: eigenvalues=0.508, Axis 2: eigenvalues=0.176).

This suggests that they may indicate deteriorated habitats, although previous studies suggest that *S.incrustatum* is associated to clean waters (Coscarón and Coscarón-Arias, 2007), it is possible that it is associated to other features of a degraded habitat detected by the RCE protocol. Thus, our data suggests that S.subnigrum may be a bioindicator of more integer habitats, while the other studied species may be bioindicators of habitat degradation.

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